AD-A103 151 ENVIRONMENTAL RESEARCH INST OF MICHIGAN ANN ARBOR AP--ETC F/G 19/6
STATUS REPORT ON SEISMIC RECORD DIGITIZING,(U)
JUN 79 F J THOMSON N00014-79-C-0350
UNCLASSIFIED ERIM-140900-1-L NL

END
DATE FILMED
9-81
DTIC

STATUS REPORT ON SEISMIC RECORD DIGITIZING

F. Thomson

June 18, 1979

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: 140900-1-L	2. GOVT ACCESSION NO: AD-A103 151
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): STATUS REPORT ON SEISMIC RECORD DIGITIZING	5. TYPE OF REPORT & PERIOD COVERED: Status Report 15 June 1979
	6. PERFORMING ORG. REPORT NUMBER: 140900-1-L
7. AUTHOR(s): E. Thomson	8. CONTRACT OR GRANT NUMBER(s): N00014-79-C-0350
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Environmental Research Institute of Michigan, Applications Division, P.O. Box 8618, Ann Arbor, MI 48107	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
11. CONTROLLING OFFICE NAME AND ADDRESS: Director, Earth Physics Program, Arctic and Earth Sciences Division, 800 N. Quincy Street, Arlington, VA 22217	12. REPORT DATE: 18 June 1979
	13. NUMBER OF PAGES:
14. MONITORING AGENCY NAME AND ADDRESS (if different from Controlling Office):	15. SECURITY CLASS (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Distribution is unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Artillery
Seismics
Acoustics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Progress is reported on digitizing existing analog recordings of artillery seismic and acoustic data.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

PROGRESS

During the week of March 19-23, 1979, ERIM geophones and hardware were deployed at Ft. Bragg, North Carolina to record seismic signals from firing artillery in the presence of background sources such as field vehicles and aircraft. The data were recorded on analog magnetic tape at two sites. For each site, the output of a 3 axis seismometer, a microphone, and time code were recorded.

At ERIM, previously recorded data from seismic studies at Eglin, Ft. Sill, and Minnesota were identified. Data from the Ft. Bragg mission were digitized and sent to Dr. Roger Turpening at MIT Lincoln Labs (Appendix A).

PLANS

Because of commitments of the seismics recording van to other field programs in June and early July, digitizing will be deferred. We anticipate to complete all digitizing and tape delivery within the next quarter.

APPENDIX

ENVIRONMENTAL
RESEARCH INSTITUTE OF MICHIGAN
P.O. BOX 8618 • ANN ARBOR • MICHIGAN • 48107
PHONE (313) 994-1200
APPLICATIONS DIVISION
Resources & Technology

6 June 1979
RT-ARL-1279

Roger M. Turpening
Applied Seismology Group
Lincoln Labs - MIT
42 Carleton Street
Cambridge, Massachusetts 02142

Dear Roger:

Enclosed please find the following items of documentation for artillery location data collected at Ft. Bragg in March 1979 and digitized in May 1979.

1. Copy of digital data log sheets (field logs)
2. A transcription of log sheets
3. A chart of events correlated by time of day
4. A list of approximate times of 175 mm shots on March 21
5. A copy of the output generated from copying 800 BPI tapes to a 6250 BPI tape (to be archived at ERIM)
6. A copy of *LABELSNIFF output (an MTS routine which lists tape file information) for the ERIM 6250 save tape
7. Rough plots of digital data for events 20-24 (NOTE: The first data channel - high gain vertical - was not plotted on some of these due to its noise content)

Under separate cover you should find 4 (four) magnetic tapes at 800 BPI containing the digital data.

These items of data and documentation should be sufficient for you to proceed with your analyses at MIT. This is in partial fulfillment of contract N00014-79-C-0350, ERIM account 140900. Of course, if you have any further question, please call.

Yours truly,

Abby R. Liskow

ARL:njm

enc.

Ft. Bragg, March 1979
Digitized May 1979

Ch.1: high gain mike	Ch.2: low gain mike	Ch.3: high gain vertical	Ch.4: low gain vertical	Ch.5: HMWB	Ch.6:	Date	Site #	Time (EST)	# Records	Event #	Tape + File #	First Run Zero-time			Description
-6	+6	-12	-6	-12		3/20/79	2	11:44	65	1	1-1				artillery-175's or 155's
-6	+6	-12	-6	-12		3/20/79	2	11:36	89	2	1-2				aircraft & artillery (see 10,16
-6	+6	-12	-6	-12		3/20/79	2	10:37	94	3	1-3				" " " (see 9,18,20)
-6	+6	-12	-6	-12		3/20/79	2	12:35	82	4	1-4				" " " *
-6	+6	-12	-6	-12		3/20/79	2	14:05	99	5	1-5				" " " *
-6	+6	-12	-6	-12		3/21/79	1	14:17	113	6	1-6				" " " *
-6	+6	-12	-6	-12		3/20/79	1	10:54	155	7	1-7**				" " " *
-6	+6	-12	-6	-12		3/20/79	1	10:57		8	1-8				"
-6	+6	-12	"	"		"	1	10:37	343	9	1-9				" (see #3, 18,20)
"	"	"	"	"		"	1	11:36	318	10	1-10				" (see #2, 16, 19)
"	"	"	"	"		"	1	11:46	308	11	2-1				artillery (see #1)
"	"	"	"	"		"	1	12:35	338	12	2-2				aircraft &artillery (see #4)
"	"	"	"	"		"	1	14:05	338	13	2-3				" " (see #5)
"	"	"	"	"		3/21/79	1	11:10	392	14	2-4				artillery - 175's
"	"	"	"	"		"	1	14:07	157	15	2-5				aircraft & artillery

*unsure whether aircraft or land vehicle
**pinch-roller on analog recorder tightened (manual start via solenoid push for remainder of data set)

Ft. Bragg, March 1979 (Continued)

Ch.1: high-gain vertical	Ch.2: high gain mike	Ch.3: low gain vertical	Ch.4: transverse horiz	Ch.5: longitudinal horiz	Ch.6: WWVB	Date	Site #	Time (EST)	# Records	Event #	Tape + File #	First Run Zero-time		Description
-5	0	0	0	0	-12	3/20/79	1	11:36		16	3-1			aircraft & artillery (see 19)
"		"	"	"	"	"	"	10:37	273	17	3-2		chan #2 disconnected	" (no good)
"	"	"	"	"	"	"	"	10:37	297	18	3-3			" (see 3,9,20)
"	"	"	"	"	"	"	2	11:36	600	19	3-4			" (see 2, 10,16)
"	"	"	"	"	"	"	"	10:37	507	20	3-5			" (see 3, 10, 18
"	"	"	"	"	"	3/21/79	"	?		21	4-1		trash at end	attempt to locate 11:10-11:18 a:
"	"	"	"	"	"	"	"	?		22	4-2			on event #14-artillery 175's
"	"	"	"	"	"	"	"	?		22	4-3		Note: bad event #	overlap end of previous event)
"	"	"	"	"	"	"	"	?	490	24	4-4			"

ENVIRONMENTAL
RESEARCH INSTITUTE OF MICHIGAN

P.O. BOX 8618 • ANN ARBOR • MICHIGAN • 48107 PHONE (313) 994-1200

APPLICATIONS DIVISION
Resources & Technology

21 November 1979
140900-2-L

Dr. Robert Andrews
Department of the Navy
Office of Naval Research
Earth Physics Program, 311 BCT, #1
Arlington, VA 22217

Dear Dr. Andrews:

This letter will document the current status of digitizing seismic records from our historical data set and requests clarification as to how to proceed. Work is being performed under contract N00014-79-C-0350.

To date, the following tasks have been accomplished:

1. Data of artillery firings at Ft. Bragg, North Carolina were collected and sent to Dr. Roger M. Turpening at MIT.
2. Existing Grayling and Zimmerman digitized seismic data were duplicated (to the extent that the old digital tapes could be read) and delivered to Dr. Turpening.
3. Some 3-component seismometer events of mortar and howitzer firing, as monitored by the circular array at Eglin Air Force Base have been digitized and sent.

At the present time, available contract funds have been exhausted. The reason for the higher than anticipated spending rate is that we have had greater than anticipated difficulty locating the old analog tapes and in locating and repairing analog tape recorders to reproduce these data.

Although ERIM could proceed to complete digitizing the remaining data if additional funds were available, it is my understanding from our telephone conversation of 16 November that you would prefer to stop work.

I have contacted George Aitkin of USA-CRREL, and he is interested in taking over the existing analog tape library along with the existing documentation. Although the details have not yet been worked out, I am reasonably confident that we can come to some mutually agreeable arrangement for transferring the data to CRREL.

I would like to thank you for your interest in ERIM's seismic data library and your support of our digitizing efforts. I hope that we can work together in the future.

Very truly yours,

Fred J. Thomson

Frederick J. Thomson

cc: D. Lowe
H. Courtney (140900)

NOV - 6 1978

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LINCOLN LABORATORY

31 October 1978

Applied Seismology Group
42 Carleton Street
Cambridge
Massachusetts 02142

Area Code 617
253-7851

Dr. Robert S. Andrews
Code 463
Department of Navy
Office of Naval Research
Arlington, VA 22217

Dear Bob,

Seven sets of artillery data exist that are important to the current seismic location research. In chronological order they are:

1968	Jefferson Proving Ground Data
1971	Huntsville, Alabama
1971	Eglin Air Force Base, Florida
1971	Ft. Sill, Oklahoma
1973	Ft. Sill, Oklahoma
1974	Grayling, Michigan
1975	Zimmerman, Minnesota

The Grayling data and the Eglin data are especially important since both were gathered in an alluvium type environment (i.e. no rock within one wavelength). In fact both areas were mostly sand. I know that the glacial till maps for Michigan show the till to be about 700-800 feet thick on the Air National Guard range where we had our 4.2 inch mortar set up. Needless to say the surface waves from recoil from Eglin look very much like those from Grayling.

Now, the Grayling and the Zimmerman data are in digital form while the Eglin data is on analog tape. Therefore the Grayling data can be had at very little cost. The Eglin data is necessary to complement NCSC's Eglin data. The other data (Jefferson, Huntsville, Ft. Sill) would help to show the variation in signal types in other geologies. The Grayling and Zimmerman data are array data whereas the others are all "single station" data.

It goes without saying that the cost to plan, prepare and collect this data was large (Jefferson approx. $30K; Huntsville (1971), Eglin (1971) Ft. Sill (1971) approx. $120K; Ft. Sill (1973) approx. $30K; Grayling $80K; Zimmerman $20K). Now, for a very modest expenditure, it can make a valuable contribution to current efforts.

In 1971 the single stations were deployed in two different geometries, circular and linear. The circular data is excellent for studying the type of useful radiation (Love, Rayleigh) as a function of azimuth. This was not done in my reports. I only made the remark that most of the time the horizontal seismometers had the largest amplitudes. The linear geometries show rate of attenuation and a simple limit of detection. The Ft. Sill (1973) data is the only data with actual seismic shell burst data. The Jefferson data is the only 8 inch howitzer data that we have. In short, I'm saying that all of the data are desirable for study. To digitize it all would be expensive. I therefore propose the following restricted program.

First, dub the Grayling and Zimmerman data at the University of Michigan computing center and deliver all dubs to Lincoln Labs.

Second, set up a digitizing facility at E.R.I.M. that has a good six trace hard copy machine in it so that the operator can see what is being digitized.

Third, man the digitizing facility with a computer operator - Harvey Wagner or Ken Knorr and a man who was on all of the above mentioned field trips - Cy Frolich. (Leo Leverault - in the case of Zimmerman). Leo Leverault should be used only as a consultant.

Fourth (this step is divided into artillery recoil and shell burst), for recoil find good high charge records for each station and digitize three such high charge records. The stations desired are all of those that used three-component seismometers. During the shell burst recording sessions (Ft. Sill 1973) only three-component seismometers were used.

Stations - The three-component stations desired for digitizing are determined as follows:

> For all 1971 data (Eglin, Huntsville, Ft. Sill) we wish all eight three-component stations that were deployed around the 1/2 km circle at each site. On the linear geometry we request all the stations with at least fair signal to noise ratio. This means for:
>
> 155 mm howitzer
> Ft. Sill - all stations Out To and Including (O.T.I.) 3 Km.
> Eglin - O.T.I. 5 km.
> Huntsville - O.T.I. 4 km.

105 mm howitzer
Ft. Sill - O.T.I. 2 km.
Eglin - O.T.I. 3 km.
Huntsville - O.T.I. 3 km.

4.2 inch mortar
Ft. Sill - O.T.I. 3 km.
Eglin - O.T.I. 4 km.
Huntsville - O.T.I. 4 km.

For the Ft. Sill 1973 data (shell burst recrods) there are four three-component stations available for Cy to examine. The report of Adams, Siekmeier and Turpening (1974) shows some 105 mm shell bursts (for example #19) to be good but others (#17) to be noisy. Cy should scan yet some others.

In the Jefferson Proving Ground data only three three-component stations were deployed. All of these were at a range of 1 km and all weapons except the 60 mm mortar were well recorded.

The low charge of all weapons - at all distant sites - especially the small weapons make excellent seismic recordings of the air wave, therefore some of those should be digitized. Cy should examine the distant stations for low charge firings to get several (say, ten) good recordings of microphone and three-component data.

Time correlation between individual tape recorders for any one given shot was achieved by recording zero time on one tape recorder (the CP-100 usually) as well as WWV and all other tape recorders recorded WWV. Therefore during the digitizing process the WWV channel must be digitized also. Thus the basic unit of digitization shall be four (4) channels of data, the three-component seismometer and WWV, except for that one tape recorder which had zero time on it. On that tape recorder five (5) channels of data must be digitized.

The length of any given record is short, usually no more than 5 seconds. Therefore the actual act of digitizing is not time consuming but rather the work lies in finding the correct data on tape. Therefore I propose that the digitizing program proceed until a fixed amount of money (whatever amount you can conveniently spend) is consumed. The digitizing should stop at that point. Naturally this implies that the data must be arranged in some order. Furthermore only a fixed amount of money should be spent to set up the digitization facility. Without such a first order limit all of the money could be consumed just getting the equipment to work. I propose a limit of six (6) man days to set up the entire digitization facility, find, select and organize the correct

analog tapes and logs. Simultaneously with that effort ERIM can take the Grayling data and the Zimmerman data to the computing center to be dubbed. After the facility is ready to run the data should be digitized in the following order:

Eglin, 1971
Ft. Sill, 1973
Huntsville, 1971
Ft. Sill, 1971
Jefferson, 1968

Now, any given analog tape will contain the data for a particular site on the circle geometry for all weapons at all charge sizes and, usually, for a site on the linear geometry as well. Therefore the digitization process will cause Cy and Ken or Harvey to jump through each tape on a site by site basis. This is fine as long as the same weapon firing event is digitized when they go to the next site. I propose that this procedure continue until the financial stop limit is reached. The value of that financial limit should be determined by you and Mr. Fred Thompson. I suggest that it will take at least 4 weeks of Cy and Ken or Harvey's time (say, $10K) to get through the data outlined here. In the beginning the going will be slow. I should make a trip to ERIM in the very beginning and in the middle also.

In summary then the digitization program should be about $13K.

1) Dub Grayling and Zimmerman data.

2) Set up digitization facility, find, organize the analog tapes and logs.

3) Digitize.

4) Turpening's trips will be funded by Lincoln.

Sincerely,

Roger Turpening/tan

Roger Turpening

cc: T. Landers, Lincoln
F. Thompson, ERIM

RSN
1031

Seismic and Acoustic Artillery Data-
Ft. Bragg NC; Eglin AFB FL, and Grayling, MI

In the past year the Office of Naval Research (ONR) funded the Environmental Research Institute of Michigan (ERIM) to digitize artillery recoil seismic data from Grayling, Michigan and Zimmerman, Minnesota and Eglin AFB Florida. Secondly ERIM under the direction of the ASG of LL-MIT collected acoustic and seismic data for an artillery exercise at Ft. Bragg, North Carolina. Some of the collected data was digitized and furnished to MIT where they are currently conducting a seismic and acoustic location program for DARPA.

Ft. Bragg Experiment

The Ft. Bragg field arrangement consisted of two stations each recording the outputs of a three component seismometer and a microphone. The vertical seismometer and microphones were double gained. The stations were placed approximately 6 km apart on the western edge of the Ft. Bragg firing range. Both stations recorded WWV time signals so that events could be correlated. The major intent of the effort was to document the degree of signal interference during a realistic firing scenario. This observation is important since the air-coupled waves recorded on a seismometer can be relatively strong and long in duration compared to the total path seismic waves. Thus a seismic system's limiting data rate will probably be lower than that of an acoustic system. The collected data was of good quality. A part of the data was used by Lincoln Laboratory for DARPA's Distributed Sensor Netowork (DSN) program to demonstrate that aircraft could be detected on microphones as well as seismometers in the

presence of muzzle blasts. The exercise also demonstrated that spatial identification of the event is a problem. Comprehensive record keeping or a sufficient number of field observers are advised for future experiments.

Dubbing of Old Data

Previously recorded (1971, 1974, 1975) seismic artillery data was for single guns and there is no confusion concerning the events or recording conditions. Three sets of that data have been examined recently by the ASG of LL-MIT under the support of DARPA.

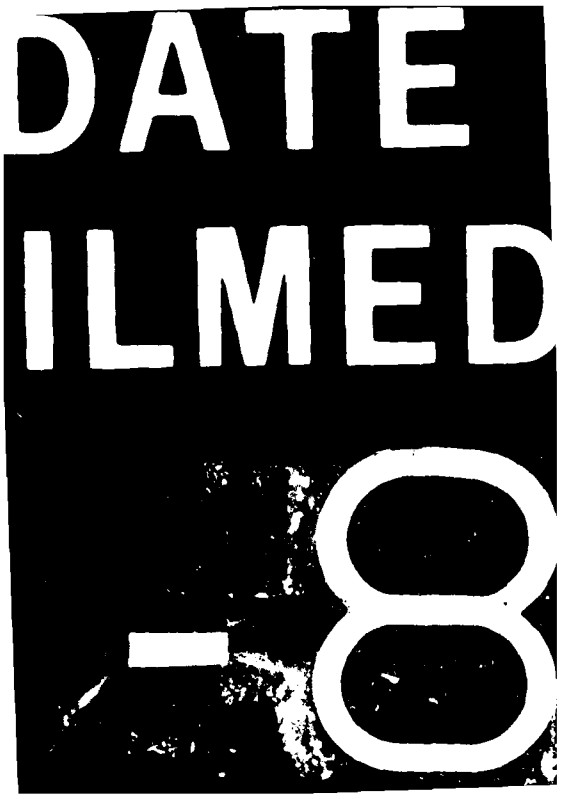
First, a rough comparison of the ERIM Eglin data of 1971 with that of the Naval Coastal Systems Center during their 1978 recording session was made. Using the P wave signal from a 4.2 inch mortar as a constant it was found that the noise level during the NCSC Eglin tests was at least 10 db higher than that during the ERIM 1971 test. The Grayling, Michigan data was also examined. These data show energy in a band around 35 Hz at 1 km and a weak signal at 2 km. The Grayling site is situated on a 200 m layer of glacial till. Using elastic velocities, Rayleigh wave dispersion curves for the Grayling area were calculated. The curves indicated that higher mode Rayleigh waves should be seen in that structure. These high frequency higher modes should attenuate quickly. The fundamental mode Rayleigh wave was found to propagate in the near surface materials where it would also be strongly attenuated. Furthermore it propagates at a group velocity near the speed of sound so that it would be hard to detect due to interference with the air-coupled seismic wave.

(why?)

Presentations

Lacoss, R.,"Time Series Analysis Seminar", Naval Post Graduate School, Monterey, CA, Spring 1979.

Landers, T. E., and Turpening, R., "Array Processing for Seismic/Acoustic Weapons Location", Third Annual Sensor Technology Meeting, WES, Fall 1979.


DATE
ILMED
8